Delaware, and has obtained stone implements from various points, both personally and by interesting friends and residents in the work he was engaged upon. He has also made a collection to show the character and relation of the peat to the river-deposits, and in various ways has made a thorough study of the connection of the river-stations with the early inhabitants of the shore.

Mr. Cresson's investigations have also been carried on in relation to the paleolithic implements found in the gravel, and he has been so fortunate as to discover two specimens *in situ* in the older gravel near Claymont, Newcastle County, Del. He also, in company with Mr. Thompson, made a visit to Indiana, and examined the gravel on White River above Medora in Jackson County. Here he was so fortunate as to find a large paleolithic implement of gray flint, in place in the gravel of the bluff of the east fork of White River. A rudely chipped implement, probably of later date, was also found in the gravel about a mile distant from the first, and was presented to the museum by Mr. Thompson.

Mr. Cresson has prepared a full account, which will soon be printed, of the discovery of these implements. In the mean while it is only necessary to call attention to the importance of these discoveries in relation to the distribution of paleolithic man in America. The value of the material for this purpose cannot be overestimated, containing as it does nearly all the implements known from the New Jersey gravels, in the Abbott and Lockwood collections, the two specimens from Delaware and one from Indiana in the Cresson collection, the two from Ohio found by Dr. Metz, and the Babbitt collection from Minnesota. For comparison with these, the museum has numerous specimens from the gravels of France and England.

Professor Putnam's remarks on the results of his researches on the Serpent Mound will be read with interest. He says, —

"We have discovered many facts pointing conclusively to considerable antiquity in the occupation of the region about the Serpent Mound. We know historically that a hundred years ago the region was inhabited by Indians, and we have found graves that probably belong to that time, or immediately preceding it, and we have also found another class of burials having every indication of far greater antiquity. Here upon the Serpent Mound Park, the property of the museum, and not far from the Serpent, are three burial-mounds with two entirely different methods of burial. Here are a village site and a burial-place occupying the same area. A recent and an early period are everywhere evident as the exploration goes on. Every thing relating to the construction of the great earthwork points to antiquity. The signs of the later occupation of the region about it have nothing remarkable: simple ash-beds where the dwellings stood; burials in the black soil, with or without protecting stones about the graves; no elaborate structures or indications of special ceremonies in connection with the burial of the dead; intrusive burials in a conical burial-mound; — every thing, on the one hand, pointing to a recent and not long-continued abode upon the spot; on the other hand, antiquity and special ceremonies; — a conical mound of considerable size, erected as a monument over the body of a single person, buried after some great ceremony in connection with fire; another mound under which were four graves (one deep down in the clay under many large stones; three others over this, with large stones about the graves and over them, and a mound of earth over all); in another instance a grave deep in the clay, with flat stones at the bottom, upon which the body was placed, and over the body many large stones, covered by the black soil of recent formation; and in this black soil, over the stones, a grave of the later period; in another place, under the black and recent soil, stones irregularly placed upon the clay, marking graves, or places where fires were made; two and three feet under these once surface-piles of stones, the graves, with skeletons so far decayed that only fragments could be secured (in several instances only the outlines of the bones could be traced in the clay; in some cases the bones in part were preserved by the infiltration of iron, and the crevices in the clay about the bones were filled with limonite, — all showing great antiquity in contrast to the more recent burials). These older burials were made in connection with ceremonies during which fire played an important part, as shown by the burial of ashes and burnt materials with the bodies, and also by the stone fireplaces near the graves. In several of these ancient graves, objects were found similar to those which we have obtained in the ancient mounds of other parts of the State. In the recent graves, with the skeletons just under the recent black soil, only now and then an arrow-point of flint or a stone celt was found, with fragments of rude pottery, such as are distributed over the surface of the village site. In the ancient graves not a fragment of pottery was found. In one of the oldest graves containing two skeletons were nearly fifty stone implements and several ornaments, among them one cut out of a crystal of galena.

"Of the two periods, our explorations have shown that it can hardly be questioned but that the Serpent Mound was built by the people of the first, that it was connected with their beliefs and their ceremonies, and that in its sacred precincts some of their dead were buried.

"This seems to be the legitimate conclusion reached by our work to this time. I shall still have time for further explorations before leaving this interesting spot, and there is much to be done in the immediate vicinity another year."

NOTES ON THE USE OF GRATINGS.[1]

THE ghosts are very weak in most of my gratings. They are scarcely visible in the lower orders of spectra, but increase in intensity, as compared with the principal line, as the square of the order of the spectrum: hence, to avoid them, obtain magnification by increasing the focal distances instead of going to the higher orders. The distances from the principal line in my gratings are the same as the distances of the spectra from the image of the slit when using a grating of 20 lines to the inch. They are always symmetrical on the two sides, and about $\frac{1}{12}$ of an inch for the violet and $\frac{1}{8}$ of an inch for the red in a grating of 21 feet 6 inches radius in all orders of spectra. When the given line has the proper exposure on the photographic plate, the ghosts will not show, but over-exposure brings them out faintly in the third spectrum of a 20,000 grating or the sixth of a 10,000 one. They never cause any trouble, as they are easily recognized and never appear in the solar spectrum. In some cases the higher orders of ghosts are quite as apparent as those of the first order.

The gratings with 10,000 lines to the inch often have better definition than those of 20,000, as they take half the time to rule, and they are quite as good for eye-observation. They can also be used for photographing the spectrum by absorbing the overlying spectra, but there are very few materials which let through the ultra-violet and absorb the longer wave-lengths. The 10,000 gratings have the advantage, however, in the measurement of wave-lengths by the overlapping spectra, although this method is unnecessary since the completion of my map of the spectrum. By far the best is to use a 20,000 grating, and observe down to the D line by photography, using erythrosin plates from the F line down to D. Below D, cyanine plates can be used, although the time of exposure is from ten to sixty minutes with a narrow slit. The solar spectrum extends to wave-length 3,000, and the map has been continued to this point. Beyond this, the coincidence with the solar spectrum cannot be used, but those of the first and second or second and third spectra can be.

Some complaints have been made to me that one of my gratings has no spectrum beyond 3,400, even of the electric arc. I have never found this the case, as the one I use gives wave-length 2,200 readily with thirty minutes' exposure on slow plates, requiring five minutes for the most sensitive part, and using the electric arc. With sensitive plates, the time can be diminished to one-fifth of this.

For eye-observations, a very low power eye-piece of one or two inches focus is best. This, with a focus of 21 feet 6 inches, is equivalent to a plane grating with a telescope of a power of 100 or 200.

In measuring the spectra, an ordinary dividing-engine, with errors not greater than $\frac{1}{1000}$ of an inch, can be used, going over the measurements twice with the plate reversed between the separate series. The plates are on so very large a scale, that the microscope must have a very low power. The one I use has a 1-inch

[1] From Johns Hopkins University Circulars, May, 1889.

objective and a 2-inch eye-piece. The measured part of the plate is about a foot long, the plates being 19 inches long.

All the spectrum photographs taken at different times coincide perfectly, and this can be used for such problems as the determination of the atmospheric lines. For this purpose, negatives at high and low sun are compared by scraping the emulsion off from half the plates, and clamping them together with the edges of the spectra in coincidence. The two spectra coincide exactly line for line except where the atmospheric lines occur.

This method is specially valuable for picking out impurities in metallic spectra, using some standard impurity in all the substances to give a set of fiducial lines; or, better, obtaining the coincidence of all the metals with some one metal, such as iron. Making the iron spectrum coincide on the two plates, the other spectra can be compared. This is specially possible, because the focus of a properly set up concave grating need not be altered in years of use; for, when necessary, it can be adjusted at the slit, keeping the distance of the grating from the slit constant.

The spectrum of the carbon poles is generally too complicated for use with any thing except the more pronounced lines of metals, there being, at a rough guess, 10,000 lines in its spectrum. However, in photographing metallic spectra, but few of these show on the plate, as they are mostly faint. The spark-discharge gives very nebulous lines for the metals.

Most gratings are ruled bright in the higher orders; but this is more or less difficult, as most diamond-points give the first spectrum the brightest. Indeed, it is very easy to obtain ruling which is immensely bright in the first spectrum. Such gratings might be used for gaseous spectra. Short-focus gratings of five feet radius of curvature, very bright in the first order, require only a fraction of a second exposure for the solar spectrum, and the spectrum of a gas can be obtained in less than an hour. H. A. ROWLAND.

NOTES AND NEWS.

A SCHOOL for boys will open Wednesday, July 3, 1889, at North Edgecomb, Me., and will continue through the long vacation. Its primary object will be to fit boys for the college-admission examinations in the fall; but others who desire to advance in their studies, or to make up deficiencies during the summer, will there find an excellent opportunity. Especial attention will be paid to those who have been conditioned in the spring examinations. The staff of instructors will consist of four Harvard graduates, who are specialists in their several departments, and experienced tutors. The location affords good facilities for tennis and base-ball, as well as for boating, bathing, and fishing. As an experienced man will have special charge of the out-of-door sports of the students, a few boys will be received who do not wish to study, but who desire to pass the summer, or a portion of it, in a pleasant and healthful locality which combines country and seashore advantages. For further particulars, address Louis L. Hooper, Harvard University, Cambridge, Mass.

— It has been announced that in the event of the final loss of the McGraw-Fiske suit, involving $1,500,000, bequeathed to the library of Cornell, Mr. Henry W. Sage of Ithaca would pay for the library building, to cost over $200,000, on which work has begun. But it has not been made public till now, that, in addition to standing the cost of the building, Mr. Sage offers, if the suit is lost, to give the library an endowment of $300,000. If the McGraw-Fiske suit is won, as is confidently expected, Mr. Sage's half a million will probably come to the university for other purposes. The giving of this sum will make Mr. Sage's benefactions to the university amount to about $1,000,000 in cash, besides counsel and services.

— In the *American Journal of Science* for March, 1887, and the *London, Dublin, and Edinburgh Philosophical Magazine* for the same month, Mr. Henry A. Rowland has published a list of standard wave-lengths, as far as could be observed with the eye, with a few imperfectly observed by photography, the whole being reduced to Bell's and Pierce's values for absolute wave-lengths. Mr. Bell has continued his measurements, and found a slightly greater value for the absolute wave-length of the D line, and Mr. Rowland has reduced his standards to the new values. Nearly the whole list has been gone over again, especially at the ends around the A line and in the ultra-violet. The wave-lengths of the ultra-violet were obtained by photographing the coincidence with the lower wave-lengths, — a method which gives them nearly equal weight with those of the visible spectrum. The full set of observations will be published hereafter, but the present series of standards can be relied on for relative wave-lengths to .02 division of Angström in most cases, though it is possible some of them may be out more than this amount, especially in the extreme red. As to the absolute wave-length, no further change will be necessary, provided spectroscopists can agree to use that of Rowland's table, as has been done by many of them. By the method of coincidences with the concave grating, the wave-lengths have been interwoven with each other throughout the whole table, so that no single figure could be changed without affecting many others in entirely different portions of the spectrum. The principal difference from the preliminary table is in the reduction to the new absolute wave-length, by which the wave-lengths are about 1 in 80,000 larger than the preliminary table. It is hoped this difference will not be felt by those who have used the old table, because measurements to less than .1 division of Angström are rare, the position of the lines of many metals being unknown to a whole division of Angström. As the new map of the spectrum has been made according to this new table, there seems to be no further reason for changing the table in the future. No attempt has been made to reduce the figures to a vacuum, as the index of refraction of air is imperfectly known; but this should be done where numerical relations of time period are desired. In the column giving the weight, the primary standards are marked S, and the other numbers give the number of separate determination of the wave-length, and thus, to some extent, the weight. Many of these standards are double lines, and some of them have faint components near them, which makes the accuracy of setting smaller. This is specially the case when this component is an atmospheric line whose intensity changes with the altitude of the sun. The principal doubles are marked with d; but the examination has not been completed yet, especially at the red end of the spectrum, and a table of the standard wave-lengths is given on p. 78 of the May number of the "Johns Hopkins University Circulars."

— Schneider & Co. of France have recently taken out a patent, as we learn from *The Engineering and Mining Journal*, for manufacturing steel containing a variable portion of copper, which is to be used in making artillery of large caliber, armor-plates, rifle-barrels, and projectiles. Ordinary copper is used for the purpose, care being taken to prevent it from oxidizing before it is mixed with the steel in the crucible; and the composition contains two to four per cent of copper, the alloy being capable of far more resisting power and more elastic and malleable than simple steel would be. This new material will also probably be valuable for making girders for building-purposes and ship-plates.

— Mr. J. S. Ames, in writing of the concave grating in theory and practice, says a word as to the difficulties of ruling gratings, which may explain why so many orders received at the Johns Hopkins University for gratings remain unfilled. It takes months to make a perfect screw for the ruling-engine, but a year may easily be spent in search of a suitable diamond-point. The patience and skill required can be imagined. For the past year, all attempts to find a point for the new ruling-engine have failed; and it is only within a few days that one has been found. Most points make more than one "furrow" at a time, thus giving a great deal of diffused light. Moreover, few diamond-points rule with equal ease and accuracy up hill and down. This defect of unequal ruling is especially noticeable in small gratings, which should not be used for accurate work. Again, a grating never gives symmetrical spectra, and often one or two particular spectra take all the light. This is of course desirable, if these bright spectra are the ones which are to be used. Generally it is not so. These individual peculiarities of gratings were fully treated by Professor Rowland in his lectures during the spring term of 1888, and have been embodied by him in a complete mathematical theory of the grating, which he has nearly ready for publication. It is not easy to tell when a good ruling-point is found; for a "scratchy" grating is